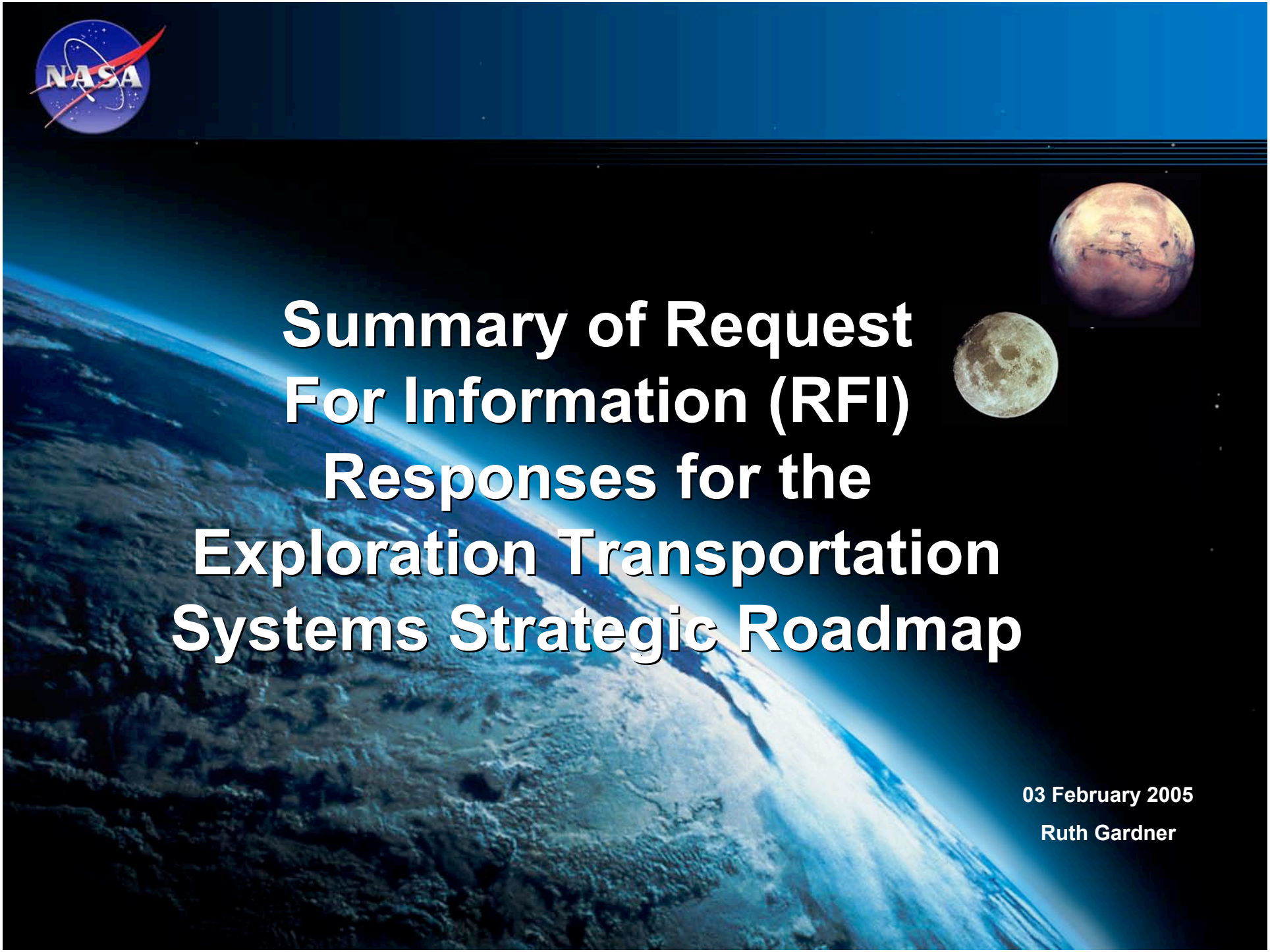

Summary of Request For Information (RFI) Responses for the Exploration Transportation Systems Strategic Roadmap

03 February 2005

Ruth Gardner

Agenda

- Background
- Summary of Responses
- Brief Description of RFI Reponses
- Conclusion

Background

- **Purpose of the NASA Advanced Planning & Integration Office (APIO) Request For Information (RFI) posted on November 2, 2004:**
  - **To solicit contributions to the roadmap development process, with the goal of ensuring that the best and widest possible set of ideas are considered in the formulation of NASA's plans for the future.**
  - **To solicit information for planning purposes only, to inform the strategic roadmap committees for possible inclusion in their final roadmap report.**

Background

- **No procurement was planned as a result of this RFI.**
- **Solicitation was open to anyone or any organization.**
- **Submitters consent to the release and dissemination of submitted information.**
- **Submission should be no longer than two pages.**
  - If the committee requires additional information on a particular paper(s) to help inform the development of the Strategic Roadmap, we can request the authors of these papers to present at the next meeting.
- **Submitter specified which Strategic Roadmap or Capability Roadmap they were addressing.**

Summary

- The Exploration Transportation Systems Strategic Roadmap received **50 whitepapers**.
- Summary of the Responses:
  - Shuttle Derived Concepts – 6 papers
  - ELV Concepts – 4 papers
  - Clean Sheet Concepts – 9 papers
  - Technologies – 13 papers
  - Suggestions and Comments – 18 papers
- Copies of all whitepapers are available for review.

Shuttle Derived Concepts

- **Six whitepapers address Shuttle Derived Concepts**
  - #10 – **Shuttle Derived Launch Vehicles for Development of an Exploration Transportation System** by ATK Thiokol Propulsion, The Boeing Company NASA Systems, Lockheed Martin Space systems Company—Michoud Operations, and United Space Alliance
  - #18 – **Spiral Development of a Lunar Heavy Lift Launch Vehicle System** by Rebecca Farr, NASA MSFC
  - #36 – **Launch Facility Options for Shuttle-derived Launch Vehicles** by Larry Johnson, ATK Thiokol Inc.
  - #37 – **Vehicle Sizing Optimization** by Larry Johnson, ATK Thiokol Inc.
  - #38 – **Exploration Transportation System for Exploration Initiative** by Larry Johnson, ATK Thiokol Inc.
  - #40 – **Development of an Exploration Transportation System** by Jeffrey Siders, United Space Alliance

Shuttle Derived Concepts

- **Common Characteristics:**
  - Propose common-component architecture to developed a family of vehicles to support various mission needs
  - Utilize Space Transportation System (STS) flight elements - External Tank (ET), Space Shuttle Main Engines (SSME) and Solid Rocket Boosters (SRB), as is or with modifications
  - Use a Saturn V J2S as a second stage engine (one proposal did not specify a second stage engine)
  - Utilize current ground systems and facilities with modifications
- **Unique Characteristic:**
  - #40 – **Development of an Exploration Transportation System** by Jeff Siders, USA
    - Proposes enhancing the current Orbiters to utilize as crew and/or cargo carrier
  - #18 – **Spiral Development of a Lunar Heavy Lift Launch Vehicle System** by Rebecca Farr, NASA MSFC
    - Proposes using LOX/Kerosene as 1st stage fuel with RD-180 engines
    - All others propose LOX/LH2 1st stage fuel with modified SSME engines
- **Upmass Capability range from 22 MT to 109 MT** (with one as high as 385 MT)
  - Upmass capability is dependent on the vehicle configuration chosen for a particular mission

ELV Concepts

- **Four whitepapers address ELV Concepts**
  - #7 – **Highway to the Moon** by Bob Citron and Walter Kistler, Lunar Transportation Systems, Inc
    - Proposes using existing EELV capability to get crew and cargo to LEO and using a new reusable spacecraft to take crews from LEO to the moon and beyond and then return
    - Refuel reusable spacecraft at locations in cislunar orbit creating a two way highway
  - #19 – **Boeing Perspectives on the NASA Space Transportation Strategic Roadmap**, Boeing NASA Systems
    - Proposes utilizing Delta IV "Heavy Plus" for 50 MT capability and shows a path of modification to the Delta IV and infrastructure to achieve 100 MT

ELV Concepts

- **Four whitepapers address ELV Concepts - Continued**
  - #28 – **Develop an Exploration Transportation System**, Constellation Services International, Inc.
    - Proposes use of Earth / Moon Lagrange points for staging for lunar missions
    - Proposes use of Progress class vehicles as space tugs to provide pressurized volumes, tankage for propellant, and communication and attitude control
    - Medium lift launcher like Atlas, Delta, or Proton to lift the tug
  - #30 – **Heavy Lift Launcher vs. On-Orbit Assembly of ETS**, MD Robotics, A MacDonald Dettwiler Co.
    - Proposes that the alternative to building a new heavy launch vehicle is more frequent flights of the existing ELV family of vehicles with emphasis on increased on-orbit assembly
    - Pros and cons are outlined for both approaches, but concludes the cost of development of a super-heavy ELV is higher than the investment in technology and logistical complexities of large scale on-orbit assembly

Clean Sheet Concepts

- **Nine whitepapers address Clean Sheet Concepts**
  - #1 – **Staged Launch and Soft Descent Capability (SLSD)** by Moonstar
    - Proposes use of a platform tethered to two large airships at 100,000 feet as a launch and recovery base for space transportation systems
  - #3 – **Building a Trail of Orbital Way Stations to Mars** by John Atcheson, Wyle Labs
    - Proposes establishing a series of “way stations” in eccentric orbits that cross Mars’ orbit and are tangential to Earth’s orbit
  - #4 – **Clean Sheet Launch Vehicle System: Saturn VII** by Fred Becker
    - Proposes a Two Stage To Orbit (TSTO) reusable vehicle that is recovered at sea with the capability to annually launch 12-million pounds to Low Earth Orbit (LEO)

Clean Sheet Concepts

- **Nine whitepapers address Clean Sheet Concepts - Cont**
  - #11 – **Hyperspace Aircraft Development** by Robert Dyck, Ardeco Aerospace, Canada
    - Proposes starting with NASA's X-43 program and lays out 5 follow-on demonstrators (leading to operational flight) using various combinations of scramjets, plasma, supersonic turbines and rocket based combined cycle technologies
  - #13 – **Mini Shuttle Space Taxi** by Robert Dyck, Ardeco Aerospace, Canada
    - Proposes a concept for an air launch space taxi using existing aircraft such as the AN-225, Airbus A380F, or a 747 to provide transport of a 4 person crew or small cargo to low earth orbit
  - #23 – **Project Bonaventure** by Capital Area Astronomy Association
    - Proposes developing a liquid methane fueled lifting body space transportation system typically operated unmanned; however, manned operations would be accomplished through the addition of a palletized Personnel Transportation Subsystem similar in concept to the GE Apollo proposal or Russian Soyuz

Clean Sheet Concepts

- **Nine whitepapers address Clean Sheet Concepts - Cont**
  - #29 – **Superconducting Electromagnetic Launch Assist Technology** by S. Mustafi and E.R. Canavan, NASA GSFC
    - Proposes use of Electromagnetic Launch Assist (ELA) system in conjunction with a two-stage scramjet/rocket vehicle to deliver payload to orbit
  - #39 – **Aeronautics Strategic Objective White Paper** by W. Ray Morgan, Morgan Aircraft Consulting in coordination with Vance Brand, DFRC
    - Proposes the development of a space launch system with an air-breathing hypersonic first stage
  - #50 – **Electromagnetic Launch Assist** by Michael R. Wright, NASA GSFC
    - Proposes earth-to-orbit transportation concept (both crew and cargo) utilizing electromagnetic forces as an assist to chemical rocket propulsion

Technologies

- **Thirteen whitepapers propose Technologies that can be utilized in the Exploration Transportation Systems**
  - Propose technologies that are mostly non-concept specific and can be utilized in most architectures
  - Examples of technologies proposed:
    - Collapsible Propellant Tanks
    - Tri-propellant Reusable Rocket Engine
    - Integrated Health Monitoring Sensor Suite
    - N2O4 In-Situ Propellant Production
  - Complete list in back-up

Suggestions and Comments

- **Eighteen whitepapers provide suggestions and comments to the Exploration Transportation Systems Strategic Roadmap**
- The suggestions and comments are very diversified ranging from acquisition strategies, decision making methods, methods for addressing obsolescence and knowledge attrition, risk mitigation approaches, life cycle engineering approaches, probabilistic comparison approaches, and others.
- Some examples of the suggestions and comments are:
  - $5.6 billion prize program to create a robust human-capable Earth-to-orbit transportation system
  - Use of sounding rockets in sub-orbital missions to develop new technology
  - Environmental impact concerns – minimize the use of non-renewable resources
- Complete list in back-up

Conclusion

- The RFI process was very successful
  - Received responses from a variety of sources
    - Industry, Academia, Internationals, Private Citizens, and NASA
  - Received responses on a variety of topics

- The whitepapers can and will help the committee lay out the Exploration Transportation Systems Strategic Roadmap

- If the committee requires additional information on a particular paper(s) to help inform the development of the Strategic Roadmap, we can request the authors of these papers to present at the next public.

Back-up

List of the Whitepapers for Exploration Transportation Systems Roadmap

Number	Title	Submitting Organization
1	Stage Launch Support and Soft Descent Capability (SLSD)	MoonStar
2	Life Cycle Engineering	United Space Alliance, LLC
3	Building a Trail of Orbital Way Stations	Wyle Labs
4	Clean Sheet Launch Vehicle systems: Saturn VII	self
5	Sustaining Support of American People through Sustainability	NASA Headquarters; Environmental Management Division
6	Development of an Exploration Transportation System	USRA
7	Highway to the Moon	Lunar Transportation Systems, Inc.
8	Untitled	NASA Office of the Chief Scientist
9	Game Technology to Education in NASA Strategic Roadmap Focus Area	US Army ARDEC
10	Shuttle Derived Launch Vehicle Concepts	Boeing NASA Systems (Houston)
11	Hypersonic Aircraft Development	Ardeco Aerospace
12	N2O4 In-Situ Propellant Production (ISPP)	Ardeco Aerospace
13	Mini Shuttle Space Taxi	Ardeco Aerospace
14	Collapsible Propellant Tank	Ardeco Aerospace
15	Collapsible Heat Shield for Aerocapture, Mars and Lunar	Ardeco Aerospace
16	Tri-propellant Reusable Rocket Engine	Ardeco Aerospace
17	Fluoropolymer Inflatables for Mars	Ardeco Aerospace
18	Spiral Development of a Lunar Heavy Lift Launch Vehicle System	ET11
19	Untitled	Boeing NASA Systems
20	Developing Effective Earth to Orbit Transportation	CSC @ NASA Ames
21	GEODE	Space Shuttle Program
22	Integrated Health Monitoring Sensor Suite for Space Exploration Vehicles	University of Louisiana at Lafayette
23	Project Bonaventure	Capital Area Astronomy Association
24	In Situ Mission Objectives Planning and Scheduling	United Space Alliance
25	Sounding Rockets in the 21st Century	JHU
26	Independent Space System Operator Concept	NASA J. F. Kennedy Space Center
27	Demonstration Missions for In-Space Assembly	United Space Alliance
28	Untitled	Constellation Services International
29	Superconducting Electromagnetic Launch Assist	NASA-GSFC
30	Heavy Lift Launcher vs. On-Orbit Assembly of ETS	MD Robotics
31	Internet Compliant Expendable Launch and Satellite Vehicles	NASA GRC
32	Virtual Mission Operations Suite for Secure Command and Control of Expendable Launch and Satellite Vehicles	NASA GRC
33	Figures of Merit for Development of Exploration Transportation System	ATK Thiokol
34	Launch Vehicle Reliability and Survivability	ATK Thiokol
35	Crew Exploration Vehicle Escape Propulsion Approach	ATK Thiokol
36	Launch Facility Options for Shuttle-derived Launch Vehicles	ATK Thiokol
37	Vehicle Sizing Optimization	ATK Thiokol
38	Exploration Transportation System for Exploration Initiative	ATK Thiokol
39	Air Breathing, Hydrogen Fueled, Hypersonic First Stage for a Space Launch System using Turbine-based, Combined Cycle Engine	NASA/DFRC
40	Development of an Exploration Transportation System	United Space Alliance
41	Countermeasure Development for the Radiation Risks for Space Travelers	JPL
42	Decision methods for Matching Booster Capacity to Payloads, etc.	National Space Society
43	A Proposal to Re-evaluate All Materials Submitted During Outreach90	National Space Society
44	Issues of Technology Obsolescence and Knowledge Base Attrition	Lockheed Martin
45	Minimum Size for Earth to Orbit Transportation	Lockheed Martin
46	A National Perspective	Lockheed Martin
47	Propulsion and Stages	Lockheed Martin
48	Modular Contingency and Redundancy Development Two Person "Mini-stations"	NASA JSC
49	Strategic Centennial Earth to LEO "Contingency" Development Program	NASA JSC
50	Electromagnetic Launch Assist (EMLA)	NASA/GSFC

Technologies

- **Thirteen whitepapers propose Technologies that can be utilized in the Exploration Transportation Systems**
  - #9 – **Game Technology Applied to Education in NASA Strategic Roadmap Focus Areas** by William H. Davis, US Army ARDEC and by Todd Borghesani, NASA-Sponsored Classroom of the Future
  - #12 – **N2O4 In-Situ Propellant Production** by Robert Dyck, Ardeco Aerospace, Canada
  - #14 – **Collapsible Propellant Tank** by Robert Dyck, Ardeco Aerospace, Canada
  - #15 – **Collapsible Heat Shield for Aerocapture, Mars and Lunar** by Robert Dyck, Ardeco Aerospace, Canada
  - #16 – **Tri-propellant Reusable Rocket Engine** by Robert Dyck, Ardeco Aerospace, Canada
  - #17 – **Fluoropolymer Inflatables for Mars Surface** by Robert Dyck, Ardeco Aerospace, Canada
  - #22 – **Integrated Health Monitoring Sensor Suite for Space Exploration Vehicles** by Dr. Stephen W. Allison, Oak Ridge National Laboratory, Dr. Daryush Ila, Alabama A&M University Research Institute, and Dr. William A. Hollerman, University of Louisiana

Technologies

- **Thirteen whitepapers propose Technologies that can be utilized in the Exploration Transportation Systems**
  - #24 – **In-Situ Crew Mission Objectives Planning and Scheduling** by Christopher Leslie, USA
  - #31 – **Internet Compliant Expendable Launch and Satellite Vehicles** by Phillip E. Paulsen, NASA GRC
  - #32 – **Virtual Mission Operations Suite for Secure Command and Control of Expendable Launch and Satellite Vehicles** by Phillip E. Paulsen, NASA GRC
  - #35 – **Crew Exploration Vehicle Escape Propulsion Approach** by Larry Johnson, ATK Thiokol Inc.
  - #41 – **Countermeasure Development for the Radiation Risks for Space Travelers** by Donald Strayer and Charles Hays, JPL
  - #48 – **Modular Contingency and Redundancy Development Two Person "Mini-Stations"** by Paul Torrance, NASA JSC

Suggestions and Comments

- **Eighteen whitepapers provide suggestions and comments to the exploration transportations system**
  - #2 – **Lifecycle Engineering** by Tom T. Williams and William C. Anderson, USA
  - #5 – **Sustaining Support of American People through Sustainability** by Theodore J. Biess, NASA HQ
  - #6 – **Development of an Exploration Transportation System** by Universities Space Research Association (USRA)
  - #8 – **Untitled** by Ann Clark, NASA HQ
  - #20 – **Developing Effective Earth to Orbit Transportation** by Al Globus, CSC at NASA ARC
  - #21 – **GEODE (Commercial/Industrial Process & Applications Platform: CIPAP)** by NASA JSC
  - #25 – **Sounding Rockets in the 21st Century – Strategic Enhancement of a Core Capability to Mitigate Risk and Cost in the NASA Vision for Space Exploration** by Dr. Stephen R. McCandliss, John Hopkins University
  - #26 – **Independent Space System Operator Concept** by Carey McCleskey, NASA KSC
  - #27 – **Demonstration Missions for In-Space Assembly** by Chris Miller, USA

Suggestions and Comments

- **Eighteen whitepapers provide suggestions and comments to the exploration transportations system**
  - #33 – **Figures of Merit for Development of Exploration Transportation System** by Scott Horowitz, ATK Thiokol Inc.
  - #34 – **Launch Vehicle Reliability and Survivability** by Mark Tobias, ATK Thiokol Inc.
  - #42 – **Decision Methods for Matching Booster Capacity to Payloads, etc** by John K. Strickland, Jr.
  - #43 – **A Proposal to Re-Evaluate All materials submitted during Outreach90** by John K. Strickland, Jr.
  - #44 – **Issues of Technology Obsolescence and Knowledge Base Attrition** by John Stevens, Lockheed Martin Corp.
  - #45 – **Minimum Size for Earth to Orbit Transportation** by Eric Hogan, Lockheed Martin Corp.
  - #46 – **A National Perspective** by Eric Hogan, Lockheed Martin Corp.
  - #47 – **Propulsion and Stages** by Eric Hogan, Lockheed Martin Corp.
  - #49 – **Strategic Centennial Earth to LEO "Contingency" Developmental Program** by Paul Torrance, NASA JSC